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AERIALS (ANTENNAS) 7

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Antennas 4 : Many antenna ideas from various sources particularly for multi-band operation & also gives information about
antenna trimming, knots for wire antennas and useful antenna rigging accessory ideas.
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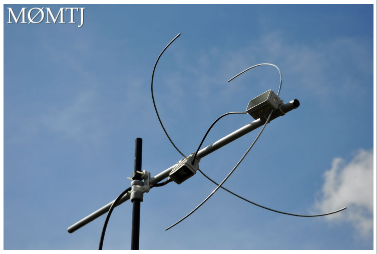
Antennas 7 : Experimental Omni-Directional - Circularly (Mixed) Polarized Antenna for VHF / 2 Meters.

"Everything should be made as simple as possible, but not simpler." - *Albert Einstein*

MØMTJ - Experimental (Almost) Omni-Directional - Circularly (Mixed) Polarized Antenna for 144 MHz / VHF / 2 Meters.



Introduction and Background

This is an experimental project that may lead to further development in the future, but even as presented below, it does work and may prove very useful.

I have therefore included this page of information so that you may can construct the aerial and develop these ideas further - either just out of interest and for the sake good old traditional Amateur Radio experimentation or for more permanent and practical uses!

The idea was sparked by the fact that I had been toying with the idea of removing the rotator and dual-band horizontal Yagi from my lightweight push-up aluminium mast to reduce mass and visual impact. I certainly did not want to lose access to the horizontally polarized portions of the 2 Metre (144 MHz) or 70cms (432 MHz) bands, so decided upon trying an Omni-Directional, horizontally polarized aerial.

The question was which antenna would I use to replace the rotatable dual-band Yagi?

Due to the weight of the rotator, the lightweight aluminium mast could not safely be pushed up higher than about 6 meters. Therefore, the Yagi on the stub mast was never much higher than 6 or 7 metres above the ground. A lighter weight omnidirectional aerial, without the heavy rotator, would allow the past to be pushed up to, perhaps, 8 or 9 meters. Maybe even to its full 10 meters on a fine day!

My thinking is that this additional height may compensate slightly for the loss of gain from the Yagi. The additional height would also benefit my vertical Coaxial Dipole for 6 Meters (50 MHz) which sits at the top of this mast. A small bonus.

I decided that I would try simple Halo antennas (HAlf wave LOop) and Big Wheel antennas for 2 Meters and 70cms.

Circularly Polarized, Omnidirectional Antenna for VHF 2 Meters / 144 MHz

.
However, before embarking on those particular experiments and possible future changes, I wanted to experiment with mixed polarization, or more correctly in this case, Circular Polarization - the subject of this project and article.

Why? - Well, when the IBA (Independent Broadcasting Authority) began building transmitters for their Independent Local Radio (ILR) in 1973, they specified that mixed polarized aerials should be used used at each of their VHF/FM

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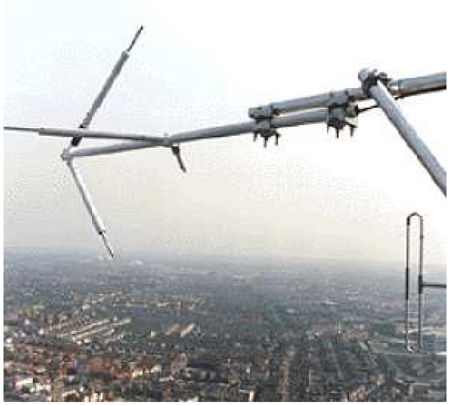
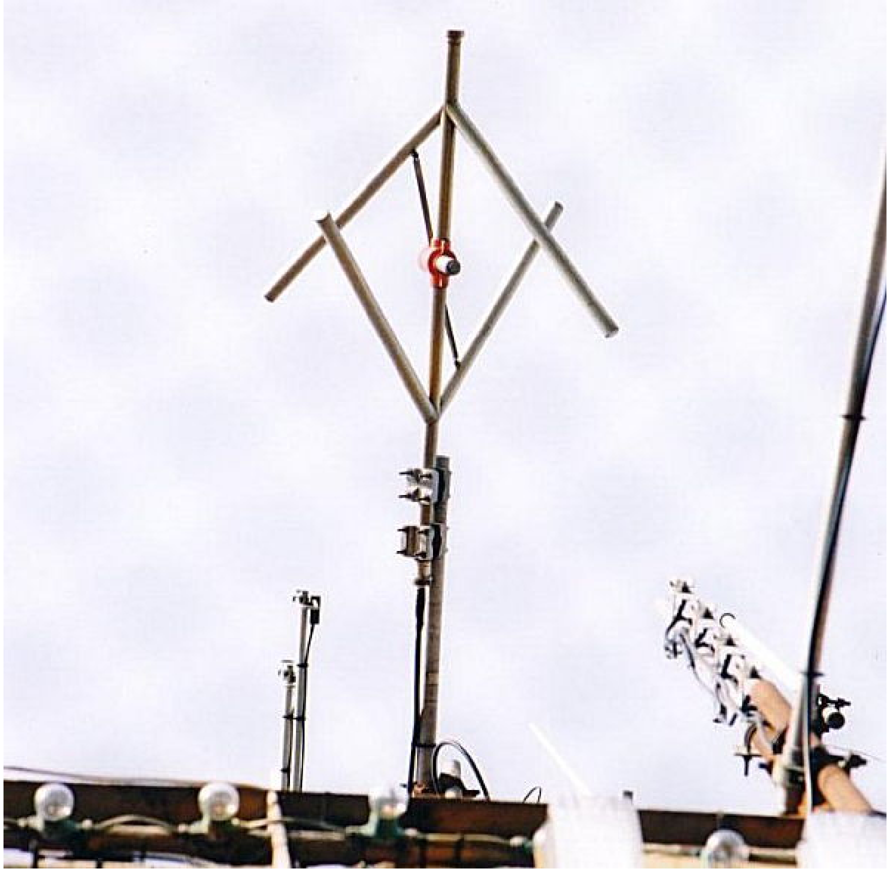
transmitter sites, starting with Croydon for LBC and Capital Radio in London, then Black Hill for Radio Clyde in Glasgow and Lichfield for BRMB in Birmingham and the many other sites that followed. The aerial systems were either described as "Mixed", "Slant" or "Circular".

The reason that mixed polarization was chosen was to improve reception on car radios and portable radios that generally used a vertical or slanted telescopic rod aerial. The BBC, at the time, used horizontal polarization for VHF/FM radio which was good for permanently installed roof-top receiving aerials, but provided poorer reception for listeners with portable sets and car radios. Some years later the BBC followed the IBA and began converting that majority of their transmitter sites to mixed polarization to improve reception and reduce mobile 'flutter' effects.

I thought that I would like to experiment with mixed polarisation and took some inspiration from some of the more recent, and simpler, antennas that have been installed at commercial radio ("ILR") transmitter sites. Two examples are shown below, both from the Radio Wave transmitter site at Blackpool Tower. The original aerial and its more recent replacement.



Original SBS transmitting aerial for
Radio Wave Blackpool 96.5 MHz
Photo from MB21.co.uk



The newer antenna viewed from below
Photo from MB21.co.uk

What's Needed

4 x 500mm lengths of 4mm diameter aluminium rod
2 x Dipole Centres

6 x Solder Tags with 3mm diameter hole
2 x Dipole Mounting Boxes - e.g. IP54 85 x 45 x 40mm
2 x Stainless Steel Nuts, Bolts and Washers M4 x 20mm
2 x Stainless Steel Nuts, Bolts and Washers M4 x 14mm
4 x Stainless Steel Self Tapping Screws No. 4 (2.9mm) diameter by 9.5mm long
1 meter of 20mm or 25mm Diameter PVC Pipe
8 x Pipe Clamps to suit diameter of boom and diameter of supporting mast
4 x Stainless Steel Nuts, Bolts and Washers
2 x End Caps to suit diameter of PVC boom (i.e. either 20mm or 25mm)
1 x SO239 Chassis Mount Socket
500mm length of small diameter coaxial cable, e.g. RG188 A / U - 50 Ohms PTFE coaxial cable
1 x piece of PVC tube for choke balun - 16mm diameter x 30mm long
1 x length of coaxial cable for phasing section
Some small self tapping screws to fix the pipe clamps to the boom

These items will be available from many and various sources, but Nuxcom is a good supplier - http://shop.nuxcom.de/

The antennas essentially comprise of two Crossed Dipoles, set a 90 degrees from each other. In the first photo, the antenna can be seen to have one dipole positioned vertically and the other horizontally. The second photograph shows that the to dipoles are again set at right angles, but one slopes 45 / 225 degrees and the other at 315 / 135 degrees.

The two dipoles are connected to each other, but have to be fed with the current to each dipole 90 degrees out of phase. This is called phase quadrature. It is a very common method used for other types of antenna, such as the Turnstile which is often used for communication with satellites where circular polarization must be used.

One dipole is connected directly to the coaxial cable. (I used Westflex 103 coaxial cable, for lowest loss, to feed the antenna). The second dipole has to be fed via a 1/4 wave (90 degrees) matching section. I had an off-cut of RG58, so used this for my initial experiment.

A quarter wave at 145.00 MHz is 300 / 145 = 2.068m / 4 = 51.7 cm. However the Velocity Factor (VF) of the cable has to be taken into account because radio waves travel more slowly through transmission lines than the do through free space.

Ideally I should have measured the VF with my antenna analyzer, however I took the typical VF of RG58 as being 0.66. So 51.7cm x 0.66 = 34.1cm. I cut the cable to 34.1 cm and used this to connect the two dipoles together.

Initially I cut the 4mm diameter aluminium rod into four 50cm long pieces and mounted them into the two dipole mounting boxes using the Nuxcom Dipole Centres. A small hole has to be very carefully drilled into the end of each rod to align with the fixing hole of the dipole centre. Then very carefully screw the 2.9mm stainless steel self tapping screws into each hole being sure not break off the head of the screws. When tapping these holes it is best to ease back and forth until the hole is successfully tapped.

The dipole centres and pipe clamps are fixed to the box with the 20mm diameter M4 hex bolts, washers and nuts.

The second pipe clamp is fixed to the box with the 14mm long M4 stainless steel hex bolt, washer and nut.

Each mounting box is fixed to the boom by clipping on the pipe clamp. The two dipoles are mounted at right angles (90 degrees) to each other, approximately 335mm apart. Once the final adjustments have been made and the positions along the boom are decided, the clamps are held firmly in place by screwing them to the boom, as can be seen in the photographs below.

Each dipole is then carefully bent into a semi-circle.

The SO239 socket is then fitted to the box and the choke balun is wound and one end of the coaxial cable soldered to the socket and the other end fitted with the solder tags. The small 2.9mm x 9.5mm stainless steel self tapping screws are then used to fix the tags to the dipole centre.

Now connect this dipole to an antenna analyzer (or SWR meter) and check the point of resonance. I decided to centre the aerial on 144.3 MHz. Almost certainly the dipole will be too long. I had to cut off 1mm of rod from each end.

Once complete, do the same for the other dipole so that they are exactly the same size.

Next, the phasing cable is prepared, as mentioned above. A suitable diameter hole is drilled in the end of the box opposite the SO239 socket and the phasing cable passed through this and soldered on to the two tags, as can be seen in the photograph below.

A similar small hole is then drilled into the other dipole mounting box and the other end of the phasing coaxial cable is passed through this, two solder tags are soldered on to the end and then fixed into place on the dipole centre using the small self tapping screws.

Now connect the antenna analyzer again, using a few metres of low loss coaxial cable, and mount the antenna in some free space, preferably outside on a pole about two or three metres above the ground a. It will almost certainly be found that the point of resonance is now two low, so each dipole will now need to be carefully trimmed, cutting small and equal amounts off each of the four ends until the point of resonance is around 144.3 MHz.

It should be possible to obtain an SWR of 1.5:1 or less across the 2 Meter band - to achieve this it may be necessary to move one of the dipole mounting boxes further away, or closer together to the other. Also, it may be necessary to bend the dipole rod of each dipole element inwards, or outwards slightly. I was able to achieve an SWR of 1:1 with an impedance of 50 Ohms according to the antenna analyzer.

Once the adjustment were complete, I used 20 meters of Westflex 103 to connect the antenna to the Icom IC-706 mk2g. A similar length of the same cable is used to connect the 5 element horizontal Yagi to the radio. A low loss coaxial switch was used to make instand comparisons between each antenna.

I raised the experimental antenna to 8 meters above ground level on the telescopic pole and began to make some comparisons.

My guess was that the experimental omni-directional circular polarized antenna would be noticeably inferior to the much higher gain, horizontal, directional Yagi.

The Yagi has a quoted gain of 8.4dDBd (i.e. gain with reference to a standard dipole - not dBi).

A standard straight dipole has a gain of 0 dBd. However if it used horizontally and is bent into a circle to produce a roughly omni-directional radiation pattern, then the gain must be reduced, so I assumed that the 'gain' must now be negative, perhaps -1 or -2 dBd.

Additionally, being as this is a circularly (mixed) polarised antenna, the power is essentially divided in half across the horizontal plane and the vertical plane. i.e. another 'loss' of 3dBd.

Therefore the gain of the antenna may be assumed to be -5dBd (minus 5 dBd), i.e. about 1 S point down on a simple straight linearly polarized aerial and about 13 dBd down compared to the Yagi - i.e. about 2 or 3 S points worse.

Here, at my QTH in Staffordshire, the Kent beacon on 144.430MHz on my 5 element Yagi is just audible, although there is no S Meter reading. I therefore did not expect to be able to hear it on the experimental antenna as it is so weak, but to my surprise, the beacon was still there - obviously a bit weaker, but still audible. That was an encouraging start!

I therefore went ahead and made some QSO's with other stations who were using both vertical and horizontal polarization and also made some comparisons purely on receive.

I therefore went ahead and made some QSO's with other stations who were using both vertical and horizontal polarization and also made some comparisons purely on receive.

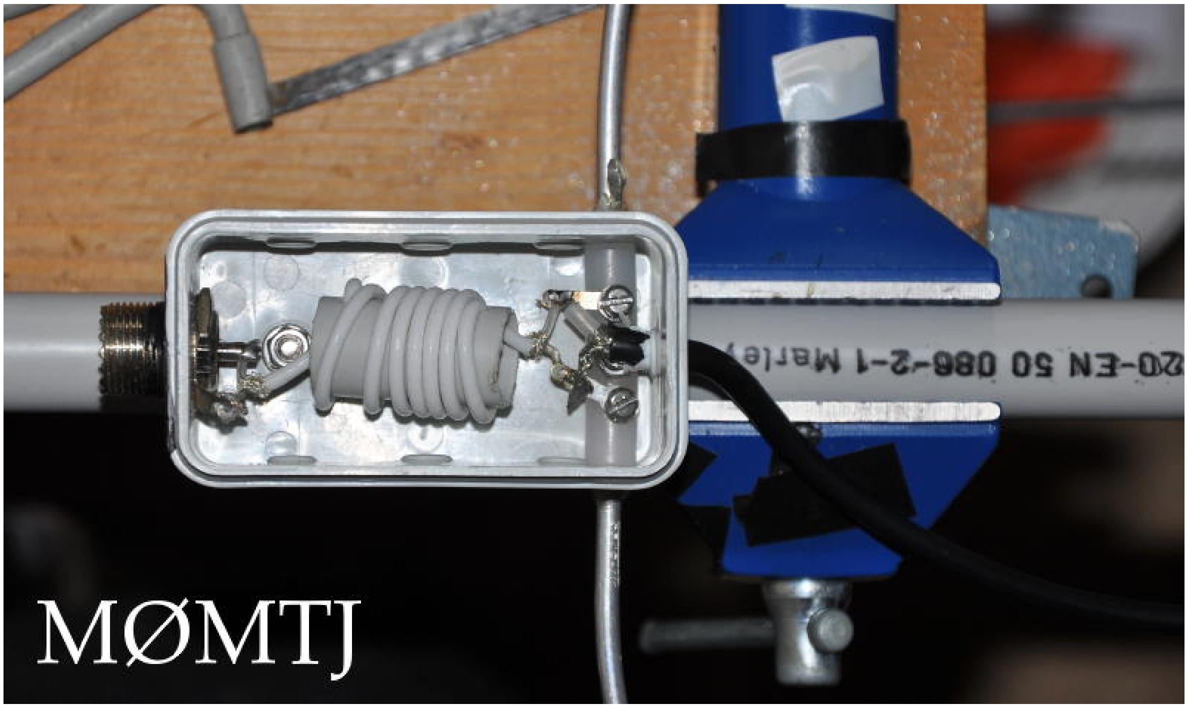
I haven't recorded enough data to draw truly meaningful conclusions. It's not scientific either. However, my impression from what I have recorded and from other general use is that the performance is broadly in line with my expectations - i.e. about 2 or 3 S points, or around 12dB, down on the Yagi.

Station	Location	QSO or RX	Mode	Other station's Aerial	Rprt Sent (Yagi)	Rprt Rec'd (Yagi)	Rprt Sent (Omni)	Rprt Rec'd (Omni)
G3XEV	Sedgley	QSO	SSB	V2000 Vertical	S2-3	S7	S6-7	S7
2W0JYN	Rhos	QSO	SSB	3 Ele Horiz Yagi	S6	S9	S5	S7
2W0JYN	Rhos	QSO	SSB	Vertical Colinear	S1	S1	S0	S0
G8WEG	SW B'Ham	RX	FM	Unknown (Vert?)	N/A	N/A	S9+20	N/A
MW0WML/p	GWNW012	QSO	FM	Vertical Dipole	N/A	N/A	S9+10	S8
G7HEM	Stourbridge	QSO	SSB	6 Ele Horiz Yagi	S7	S9	S2	S3
N/K	Burton	RX	SSB	Unknown (Horiz?)	S9	N/A	S5	N/A

With particular thanks for John G3XEV and Steven 2W0JYN for their assistance with these initial tests!

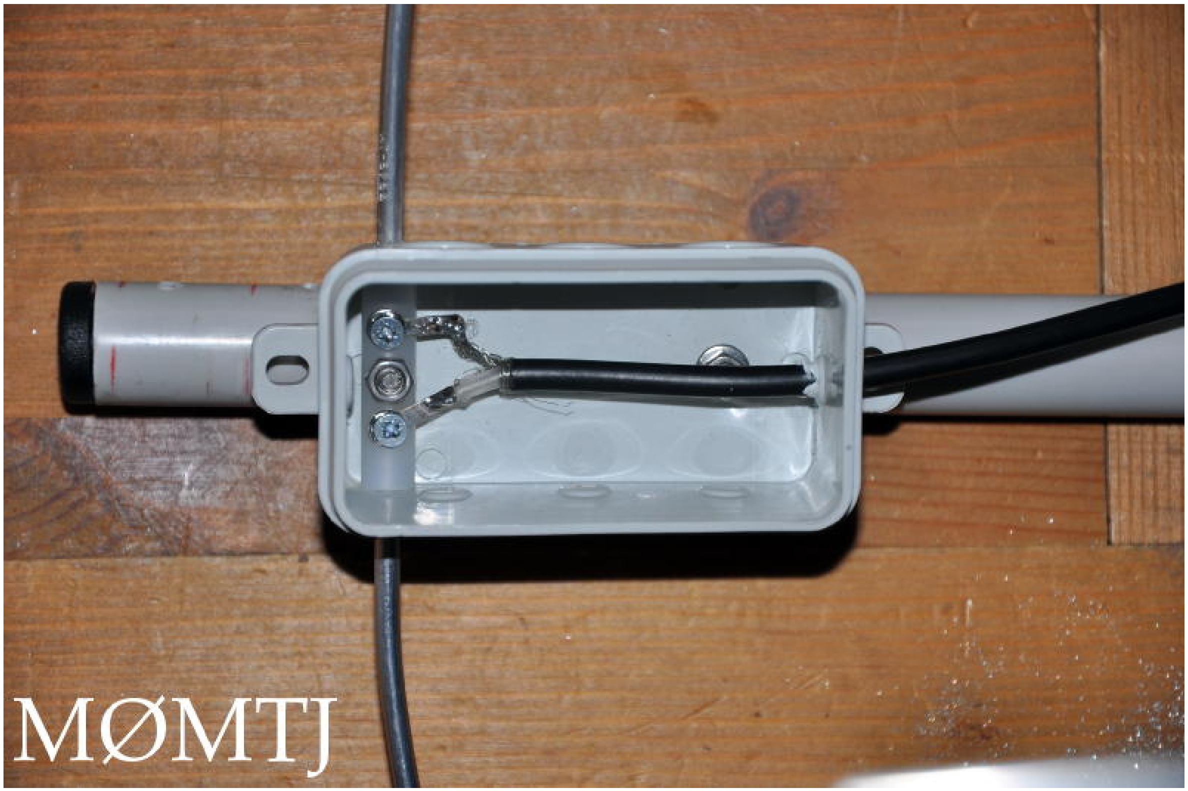
I hope this information is useful and may encourage you to experiment further and make some much better scientific comparisons!

If you have any comments, please do email them to me via the contact page here.

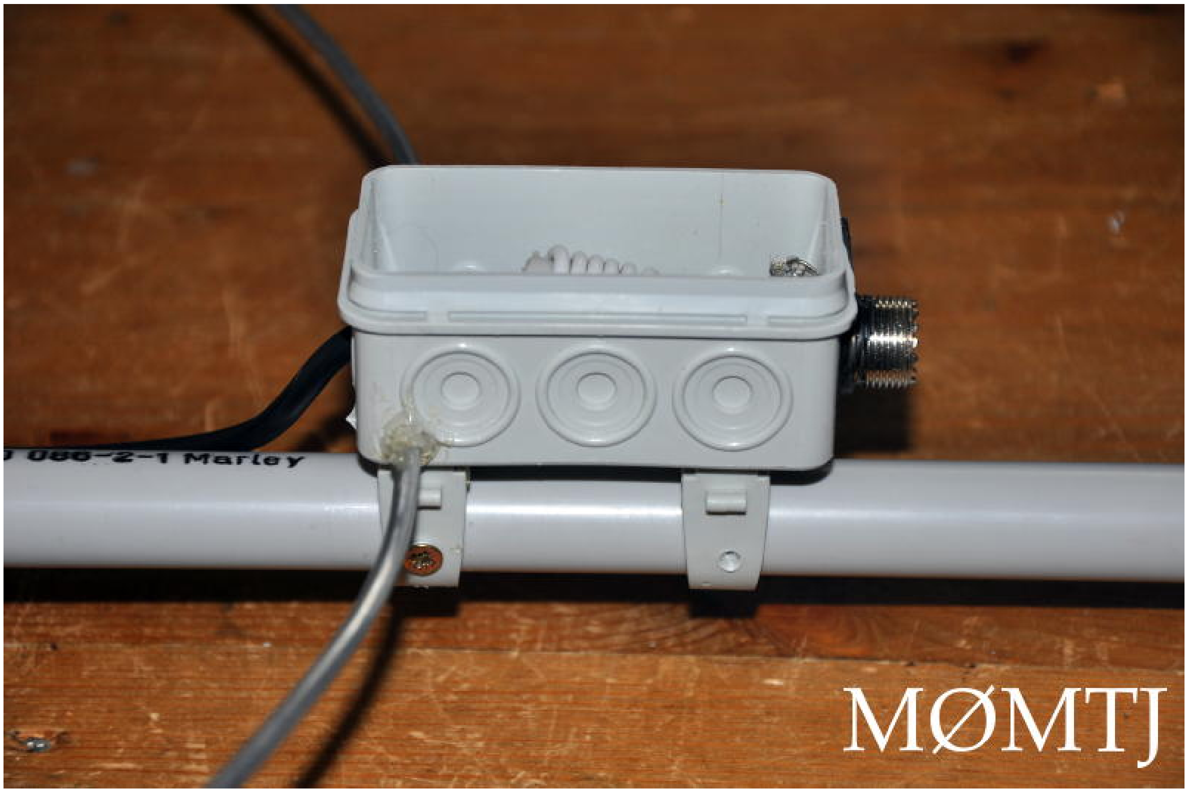


Detail showing the inside of the first dipole mounting box with SO239 socket and choke balun

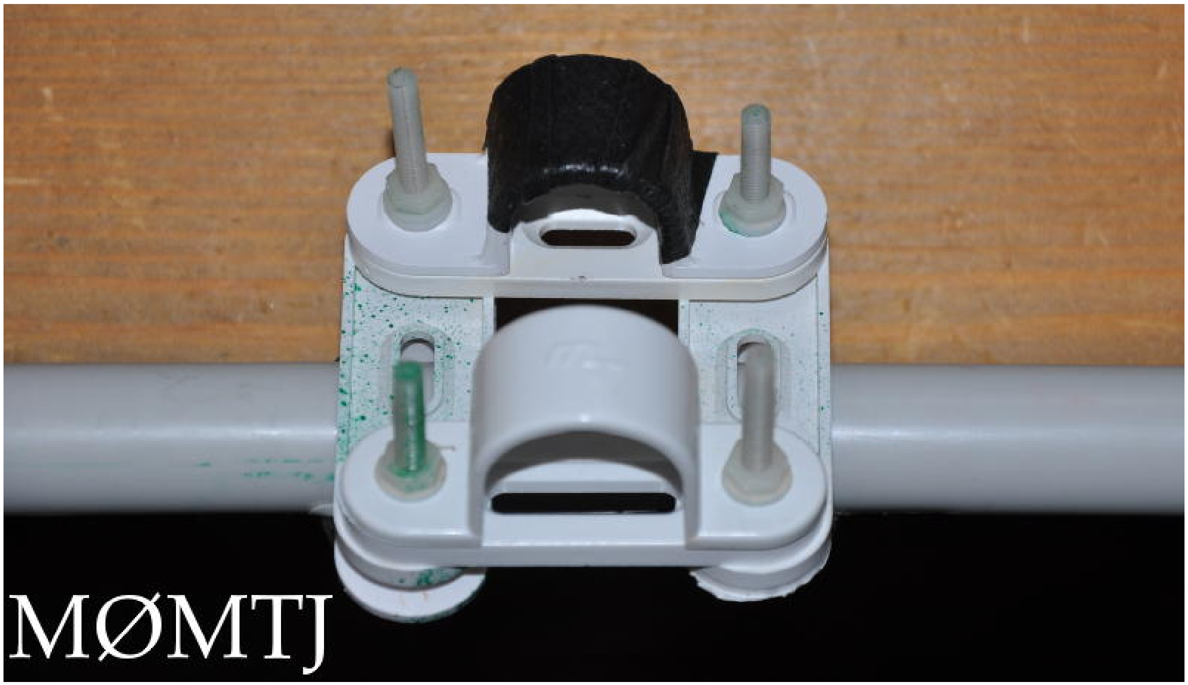
Nuxcom Dipole Centre for 4 mm dipole rods
10 mm space between dipole rods
Three holes: One in the middle for fixing the box on the boom. The other two for connecting the cable to the dipole rods.
Length: 36 mm
Space in the between rods: 10 mm
Outer diameter: 8.4 mm
Inner diameter: 4,1 mm
Material: Polyamid
http://shop.nuxcom.de/



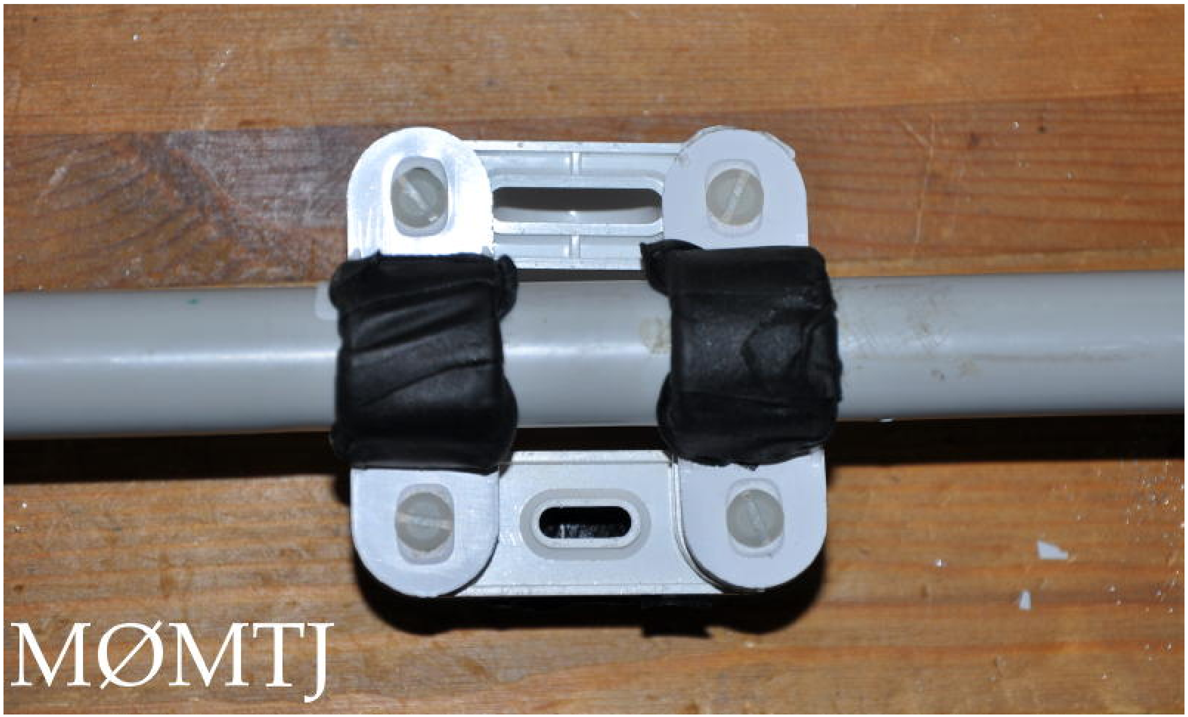
Detail showing the inside of the second dipole mounting box



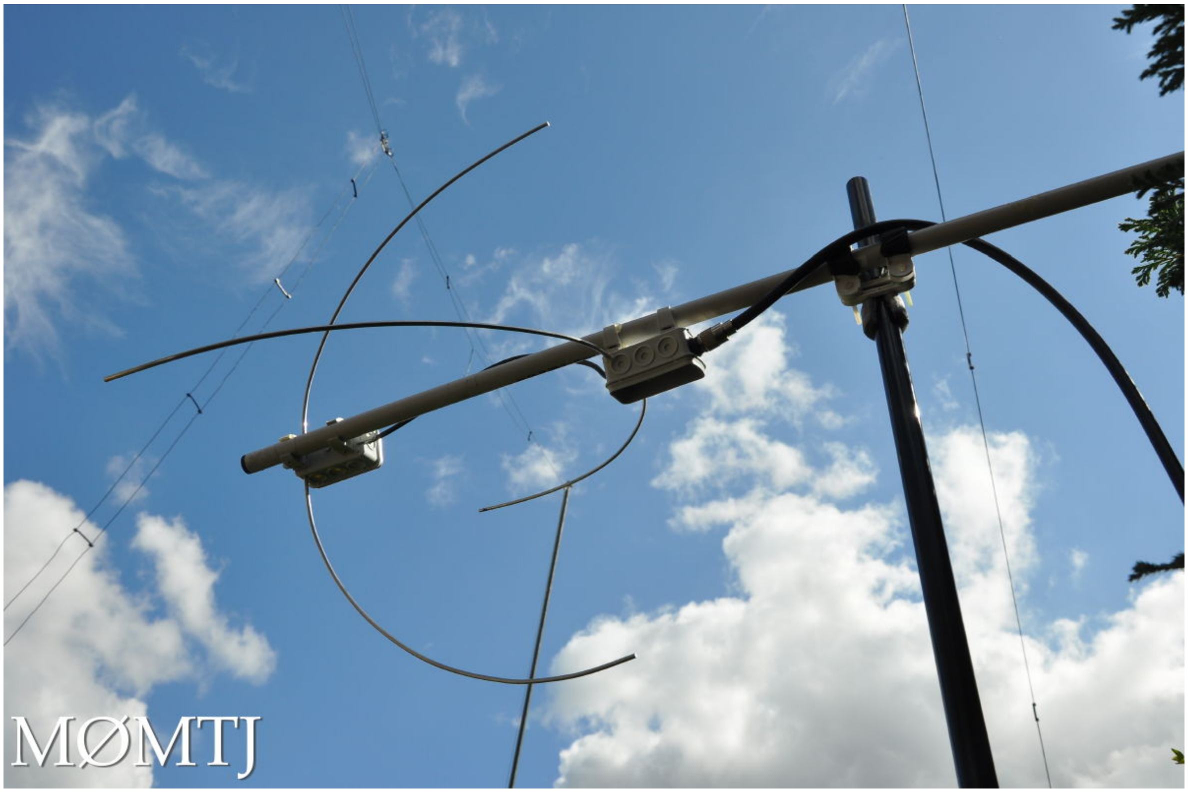
Detail showing how the dipole mounting box is fixed to the plastic pipe with pipe clamps and firmly secured in place with small self tapping screws.



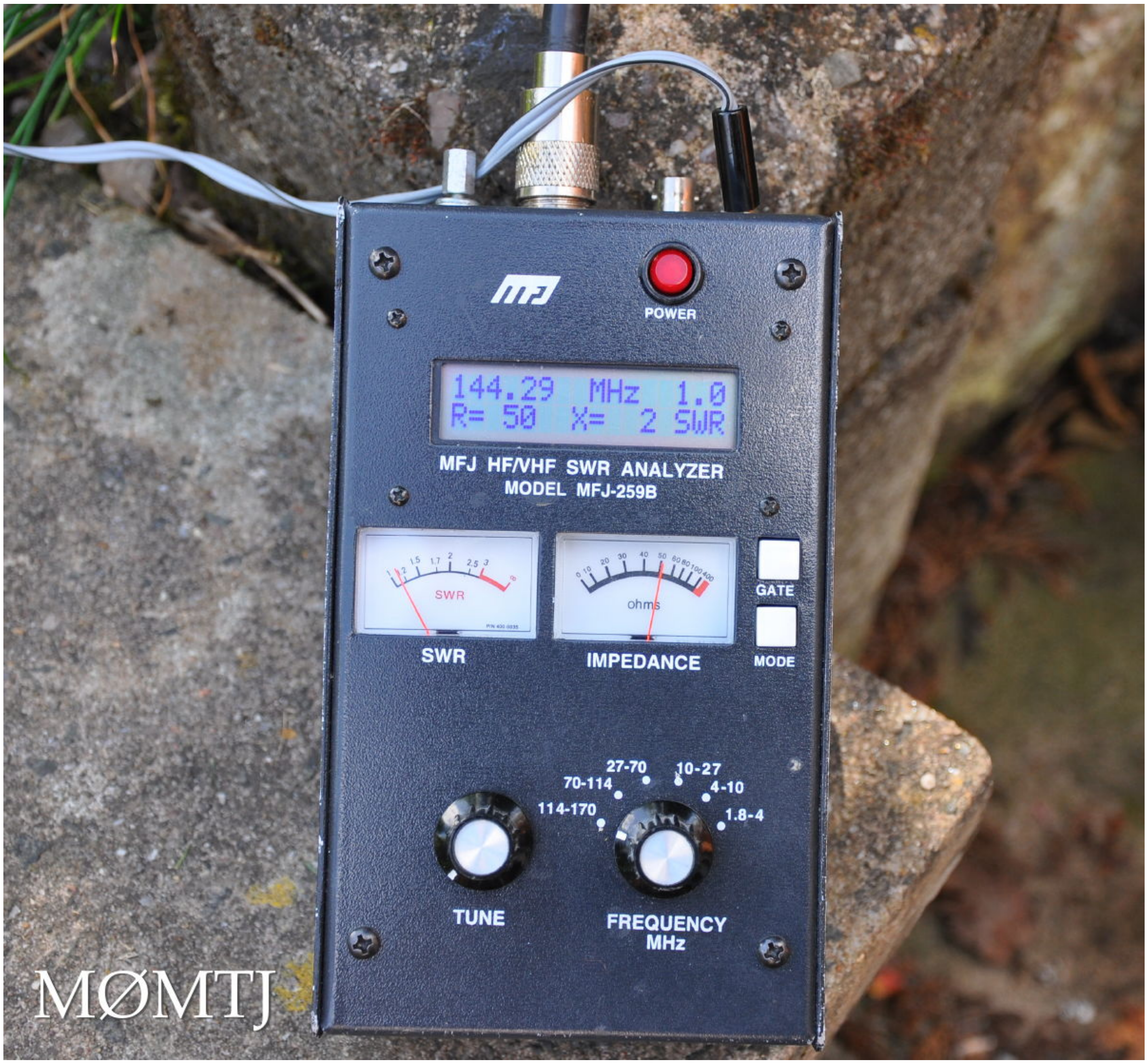
Right angled mast to boom clamp made from four plastic pipe clamps



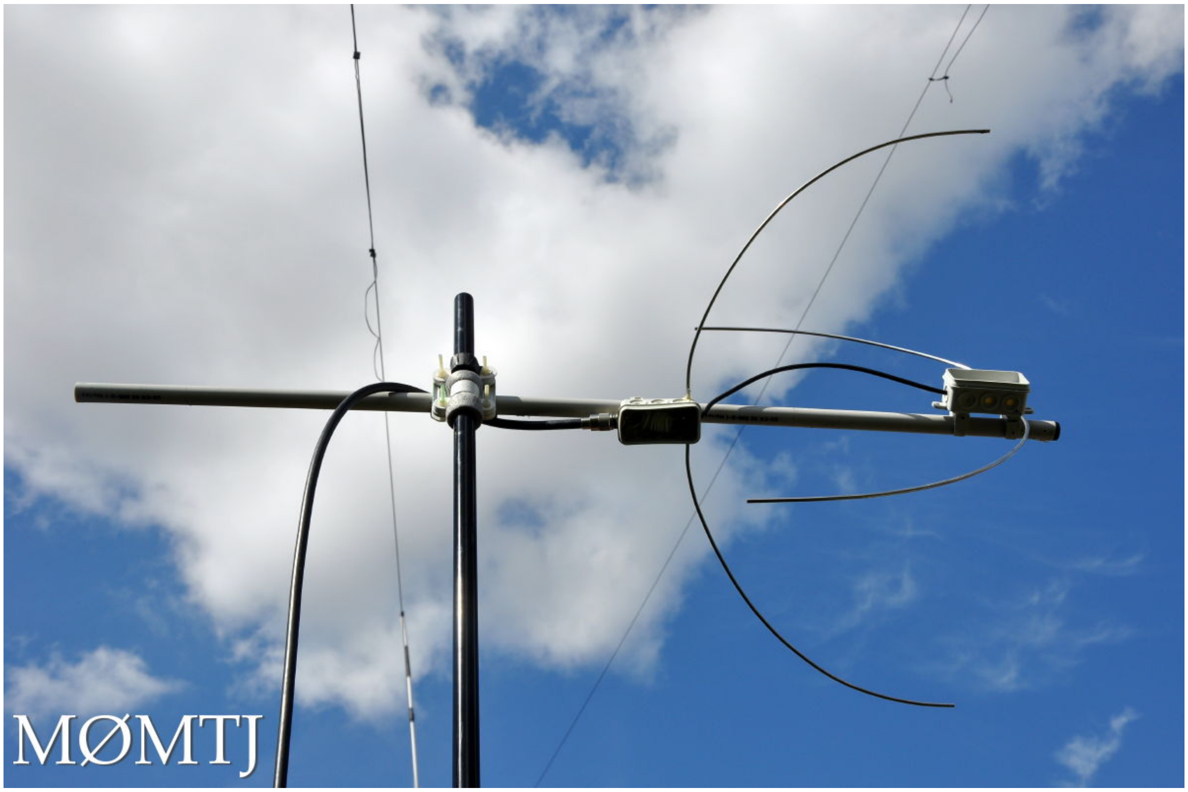
Right angled mast to boom clamp made from four plastic pipe clamps

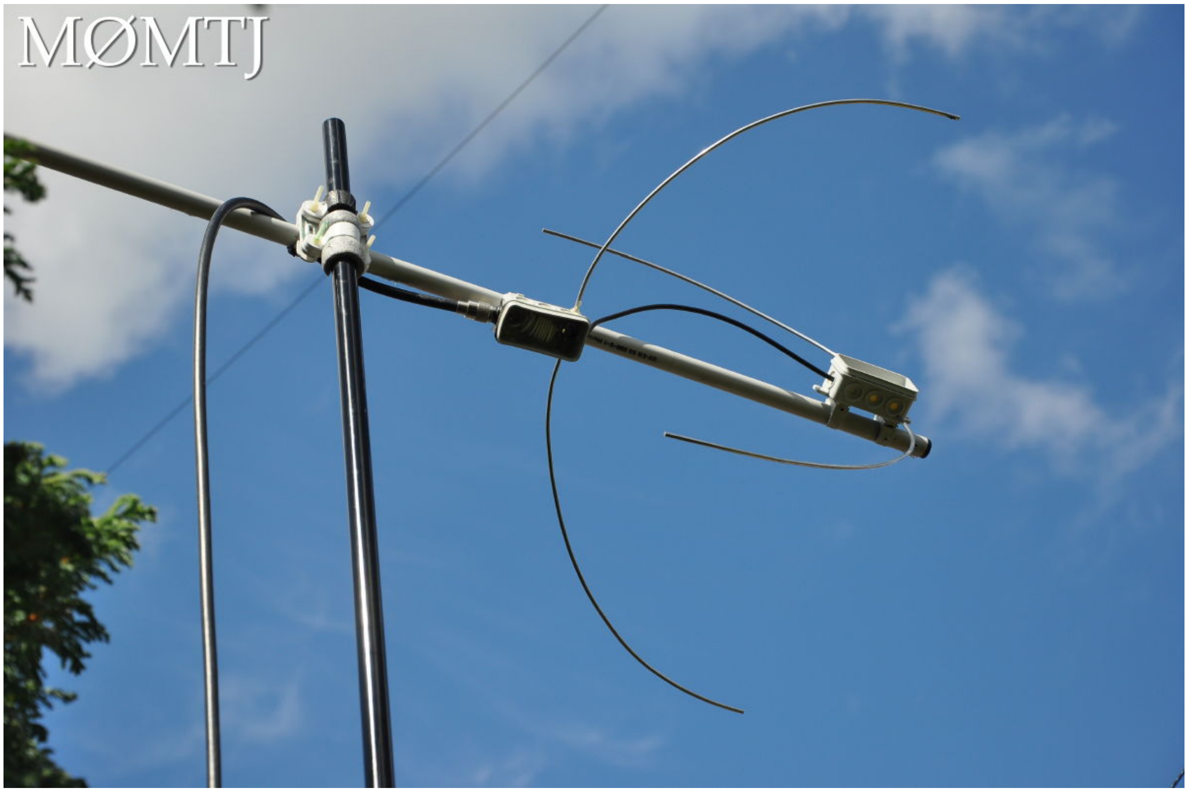


Antenna under initial test and adjustment at approximately 2 metres a.g.l.
The coaxial cable is low loss Westflex 103
(My HF Doublet antenna, fed with open wire balanced line can be seen in the background on the left)



After adjustment to element lengths and dipole positions along the boom arm, the antenna shows a good match.

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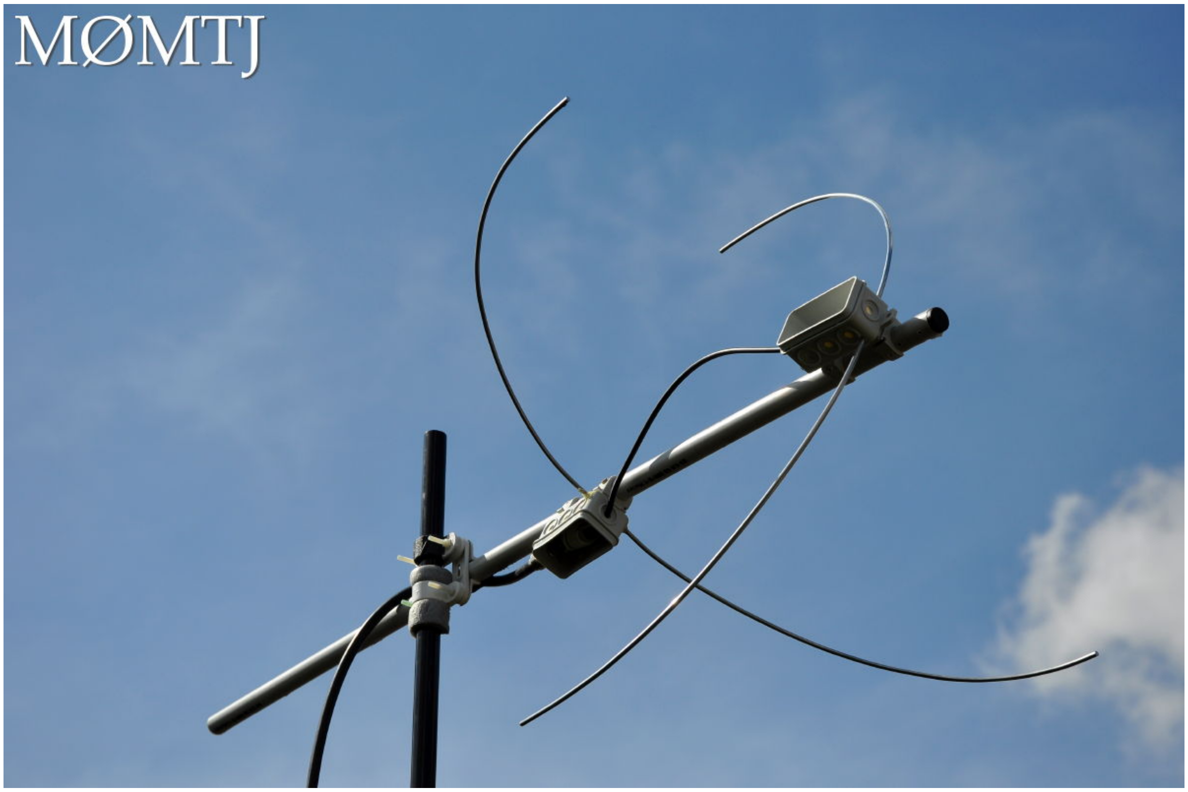
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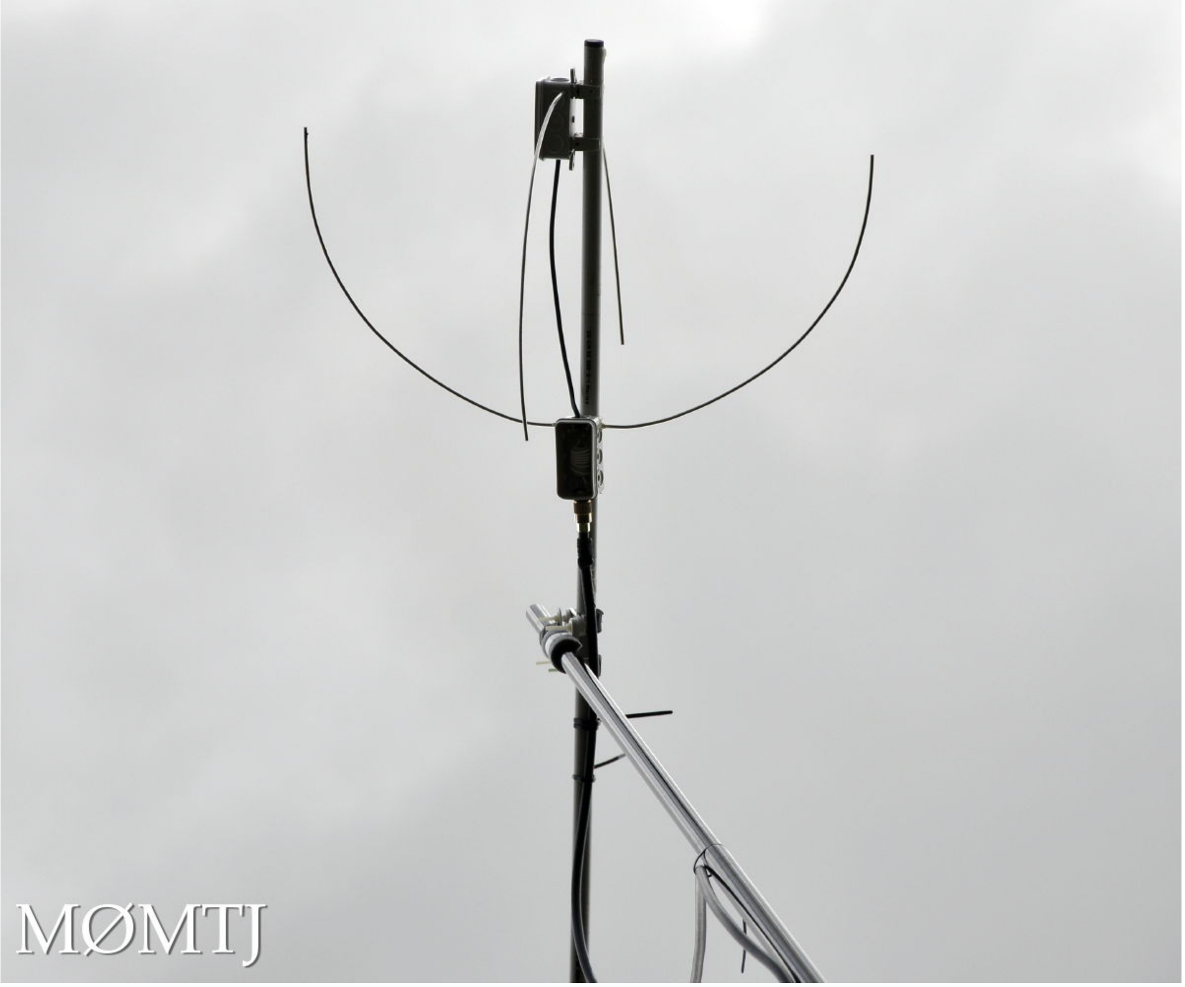
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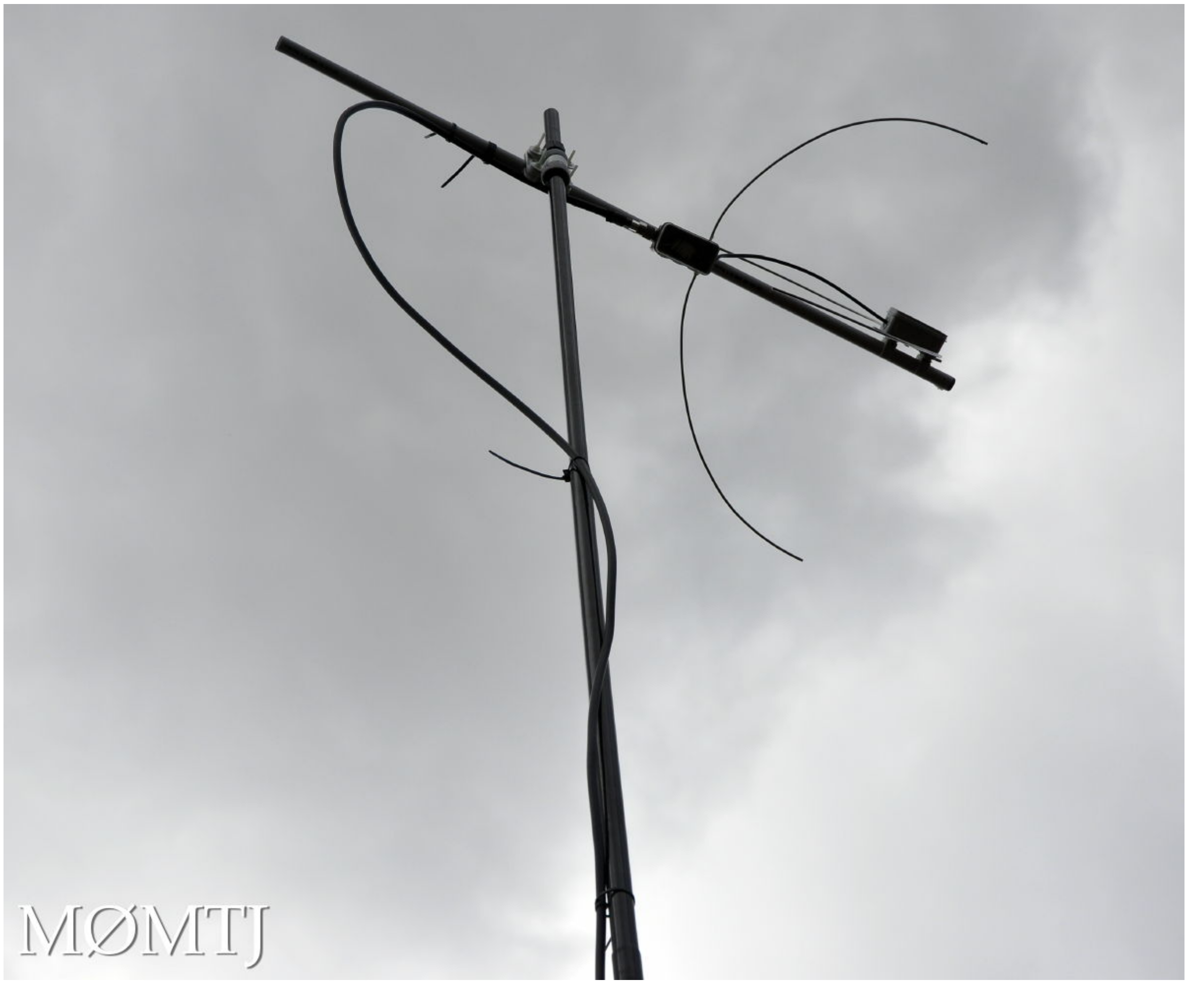
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The Test 'Rig' comprised of a heavy duty Spiderbeam 12m fibreglass telescopic pole with the antenna mounted approximately 8 meters a.g.l.

If you have any comments, please do email them to me via the contact page here.

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